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Cochran

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(54) **GRAPPLE GRINDER**

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B02C 21/02 (2006.01)
B02C 18/22 (2006.01)

(52) **U.S. Cl.**
CPC ***B02C 18/2275*** (2013.01); ***B02C 21/026*** (2013.01); *B02C 2021/023* (2013.01)

(58) **Field of Classification Search**
CPC B02C 18/2275; B02C 21/026; B02C 2021/023; B02C 21/02
USPC 241/101.72, 101.73, 101.742, 101.763, 241/101.77
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,537,404 A		1/1951	Garretson	
2,836,023 A		5/1958	Caldwell	
4,232,719 A		11/1980	Payton	
4,236,554 A	*	12/1980	Nicholson	A01G 23/08 144/174
4,355,670 A		10/1982	Ohrberg et al.	
4,412,660 A		11/1983	Morin	
4,550,554 A		11/1985	Lundahl et al.	
4,690,224 A		9/1987	Shwez	
4,767,067 A		8/1988	Bruer et al.	
4,934,612 A		6/1990	Johnson	
6,659,378 B2		12/2003	Di Anna	
7,096,900 B2		8/2006	Schafer	
8,117,771 B2		2/2012	Risi	
2002/0124442 A1	*	9/2002	Waddington, Jr.	E02F 3/404 37/406
2007/0107270 A1	*	5/2007	Edmond	E02F 3/142 37/403

* cited by examiner

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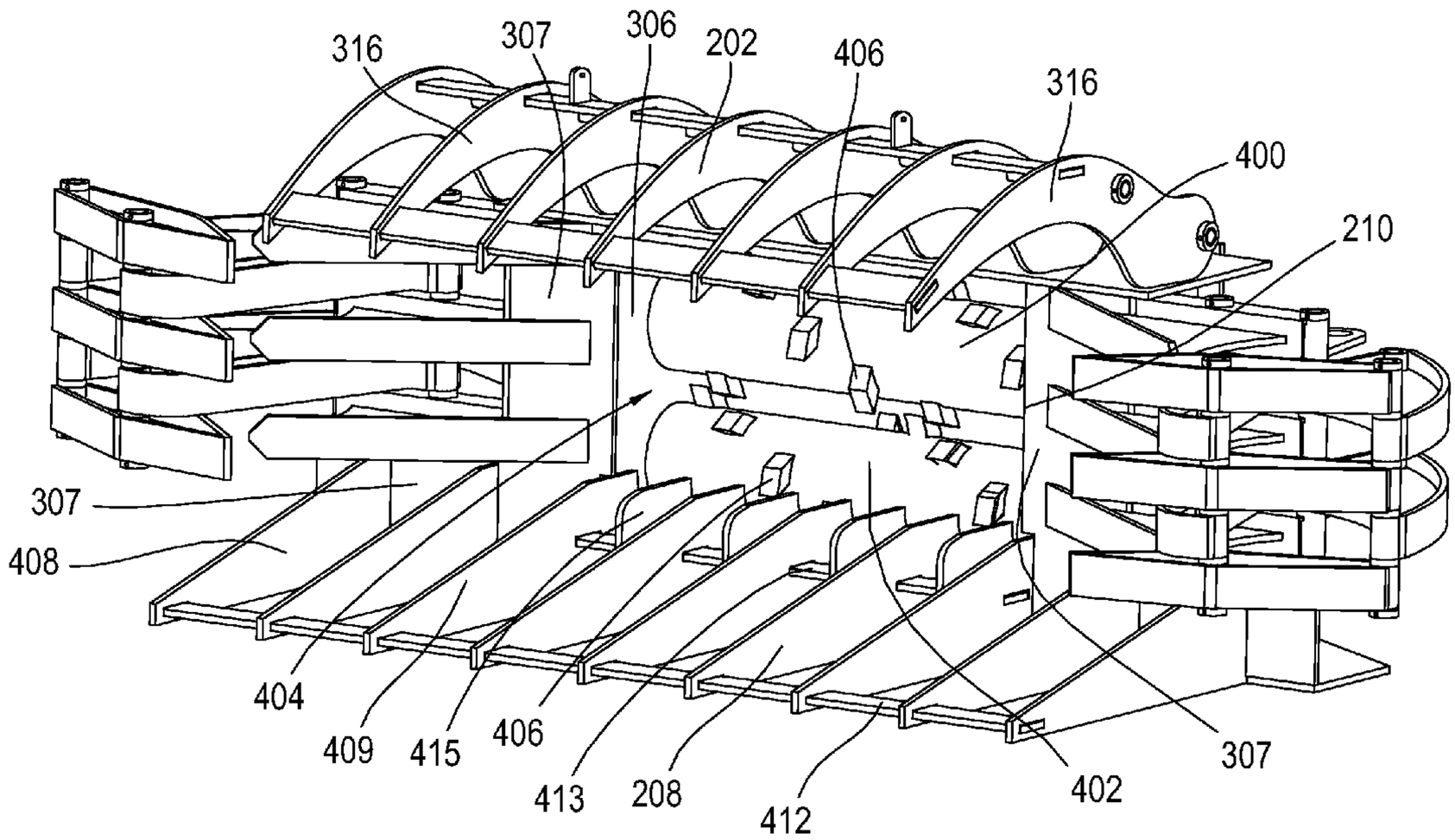
(57) **ABSTRACT**

A portable grinder unit includes a plurality of grinder heads for rending waste debris. A pair of side grapple arms are independently movable between a receive position and a feed position. A top grapple arm is movable between a receive position and a feed position. The grinder unit is mountable to a support vehicle and can receive mechanical power from the support vehicle.

19 Claims, 11 Drawing Sheets



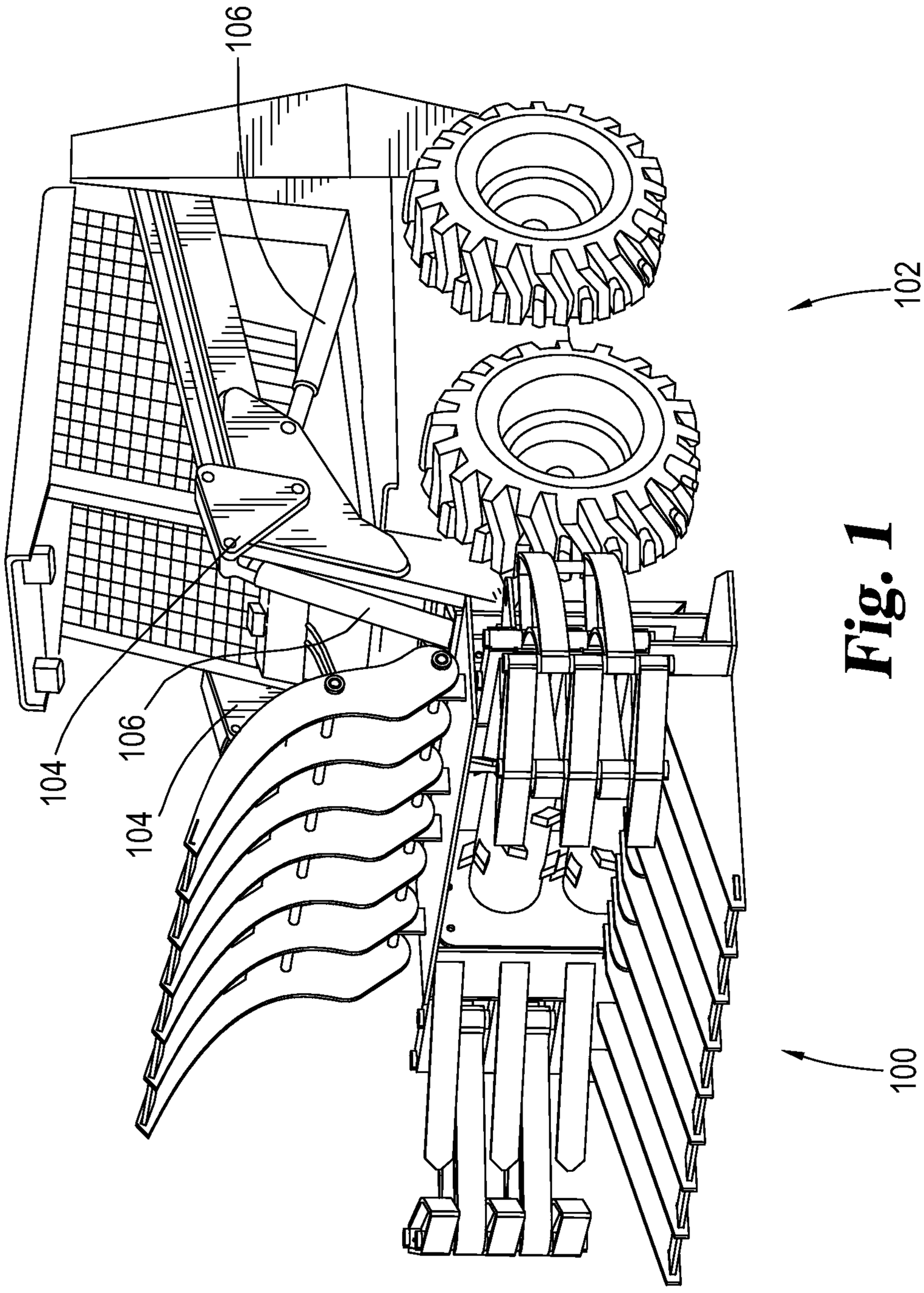


Fig. 1

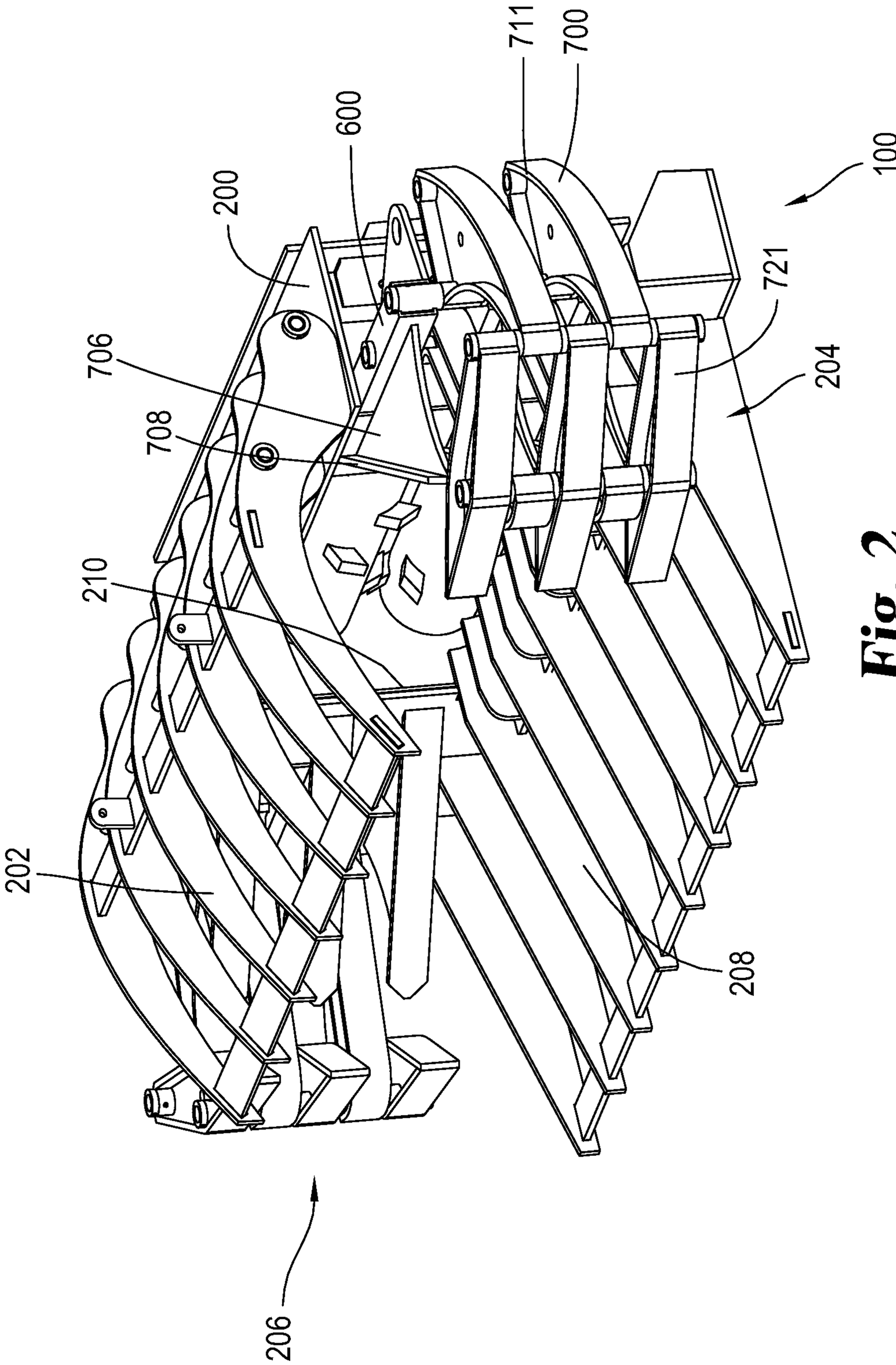
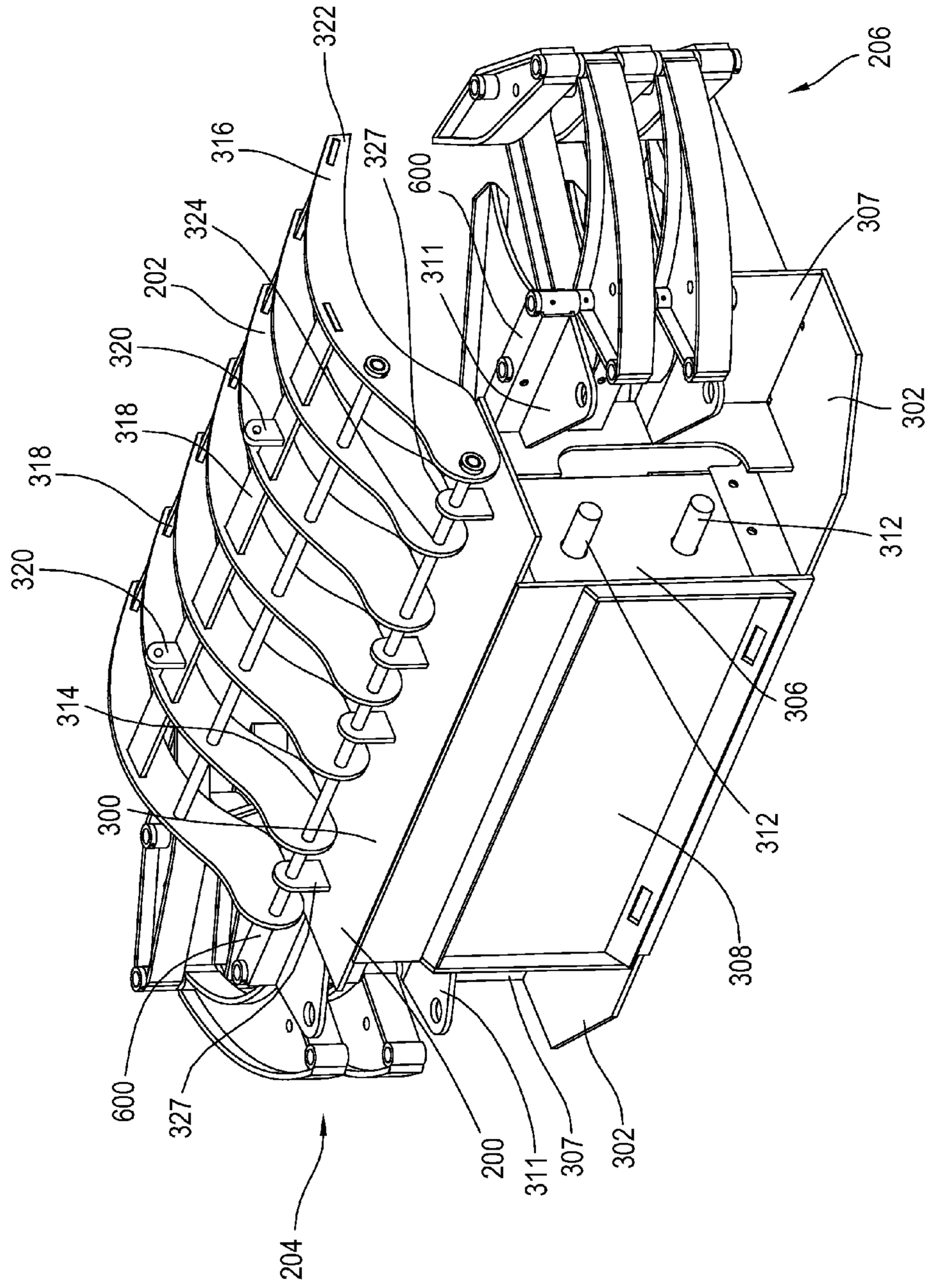


Fig. 2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316
327
600
324
202
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318
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300
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204
200
311
307
302
206
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306
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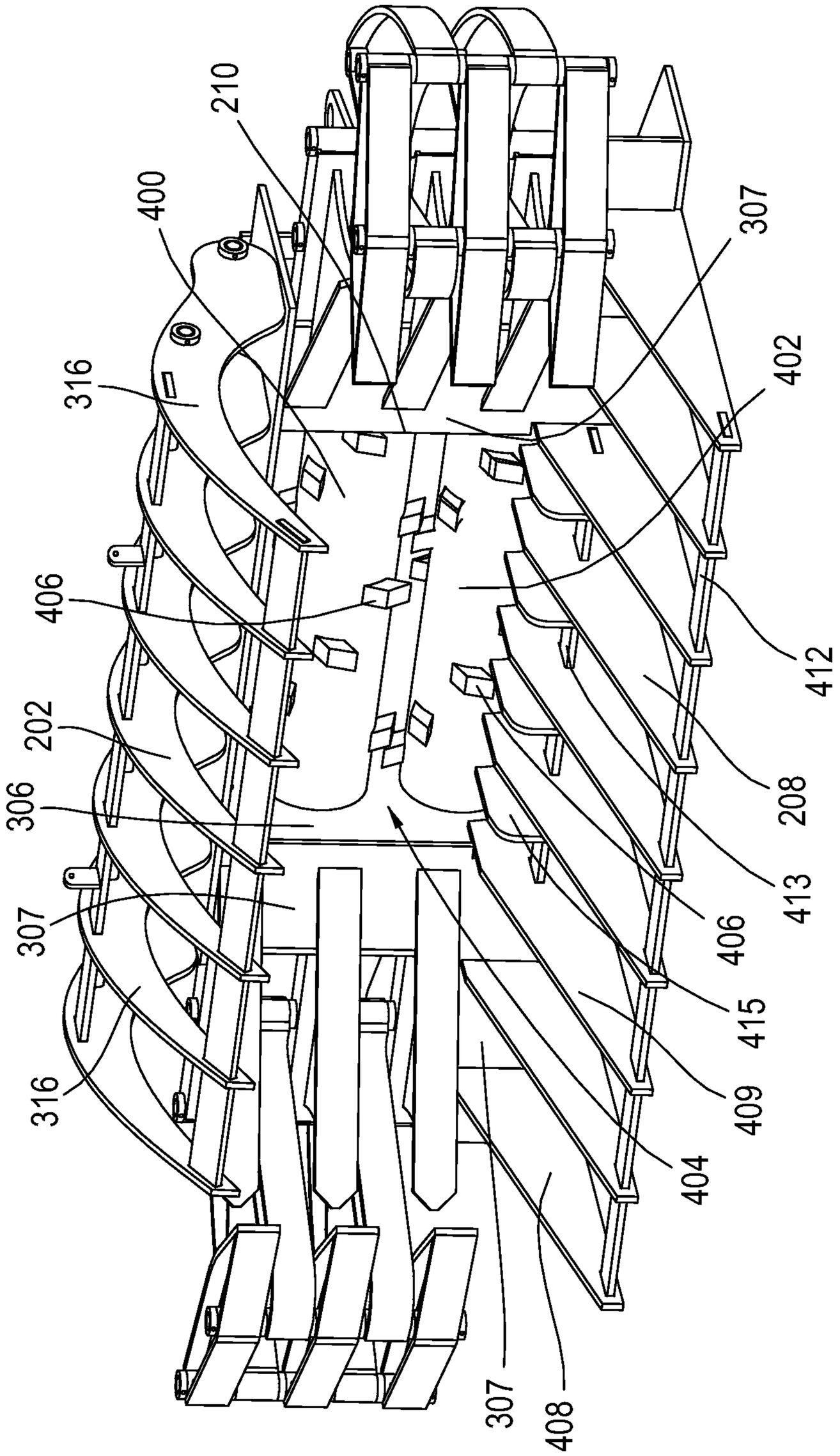
308

Fig. 3


210
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307
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406
202
306
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316
402
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208
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404
307
408

Fig. 4

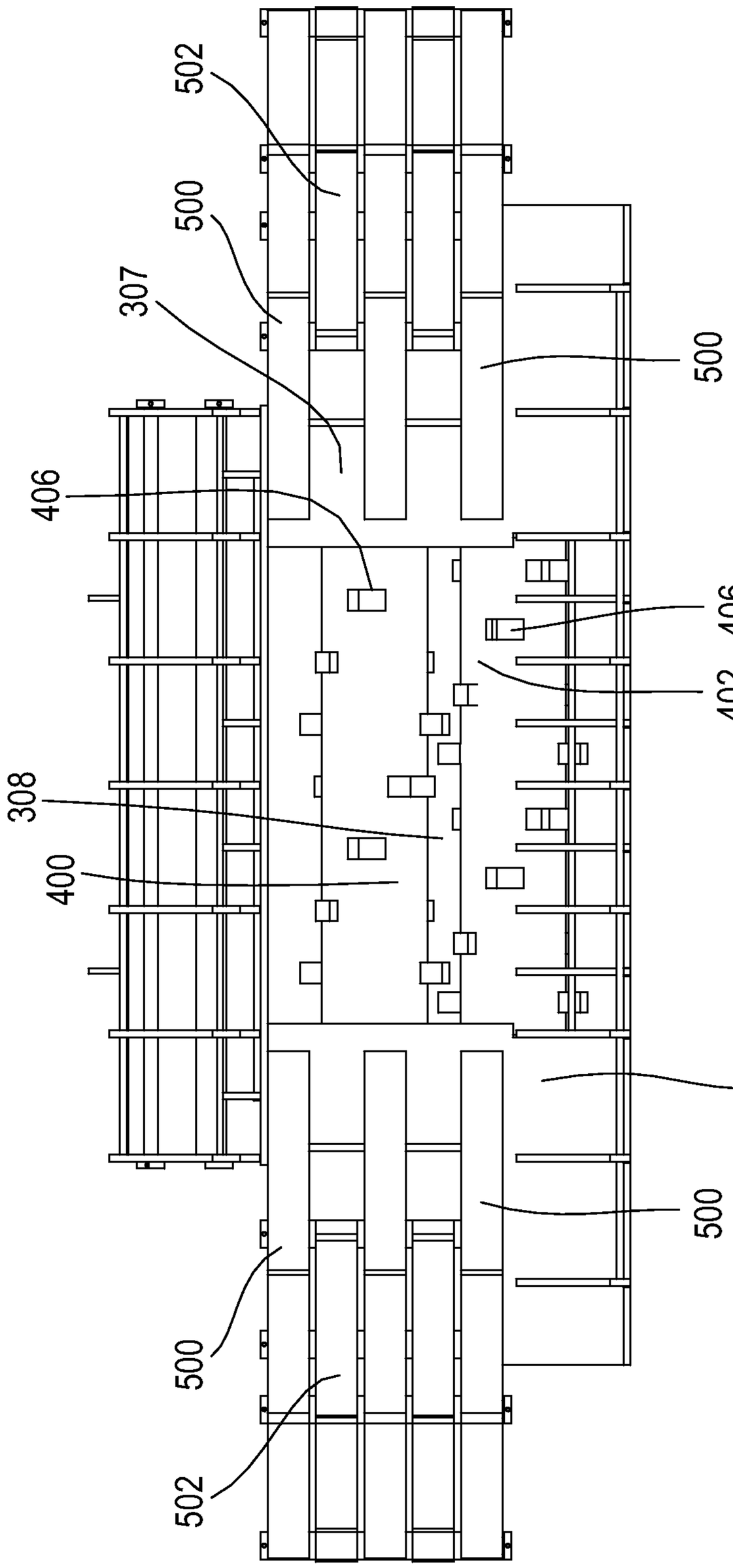
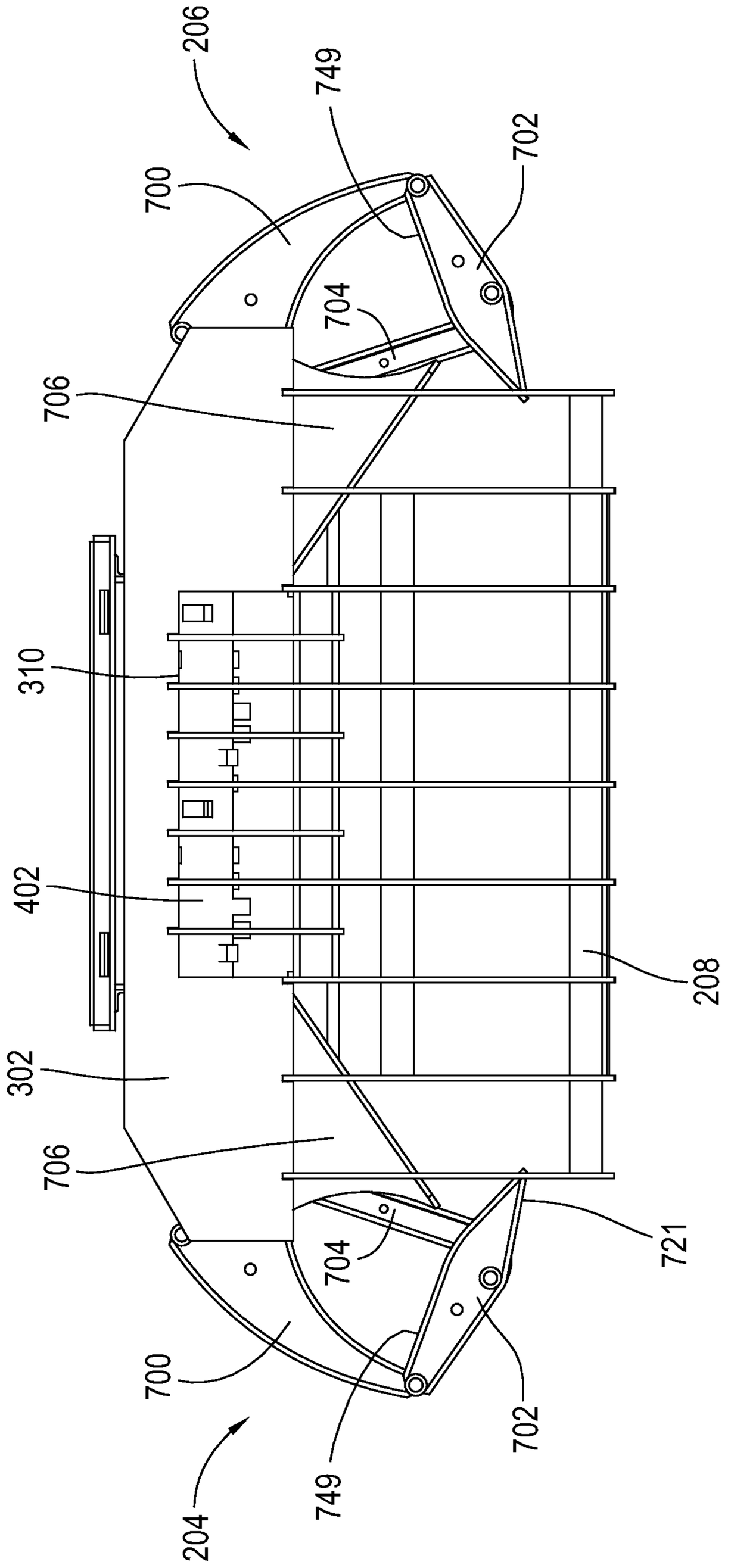


Fig. 5


206
749
702
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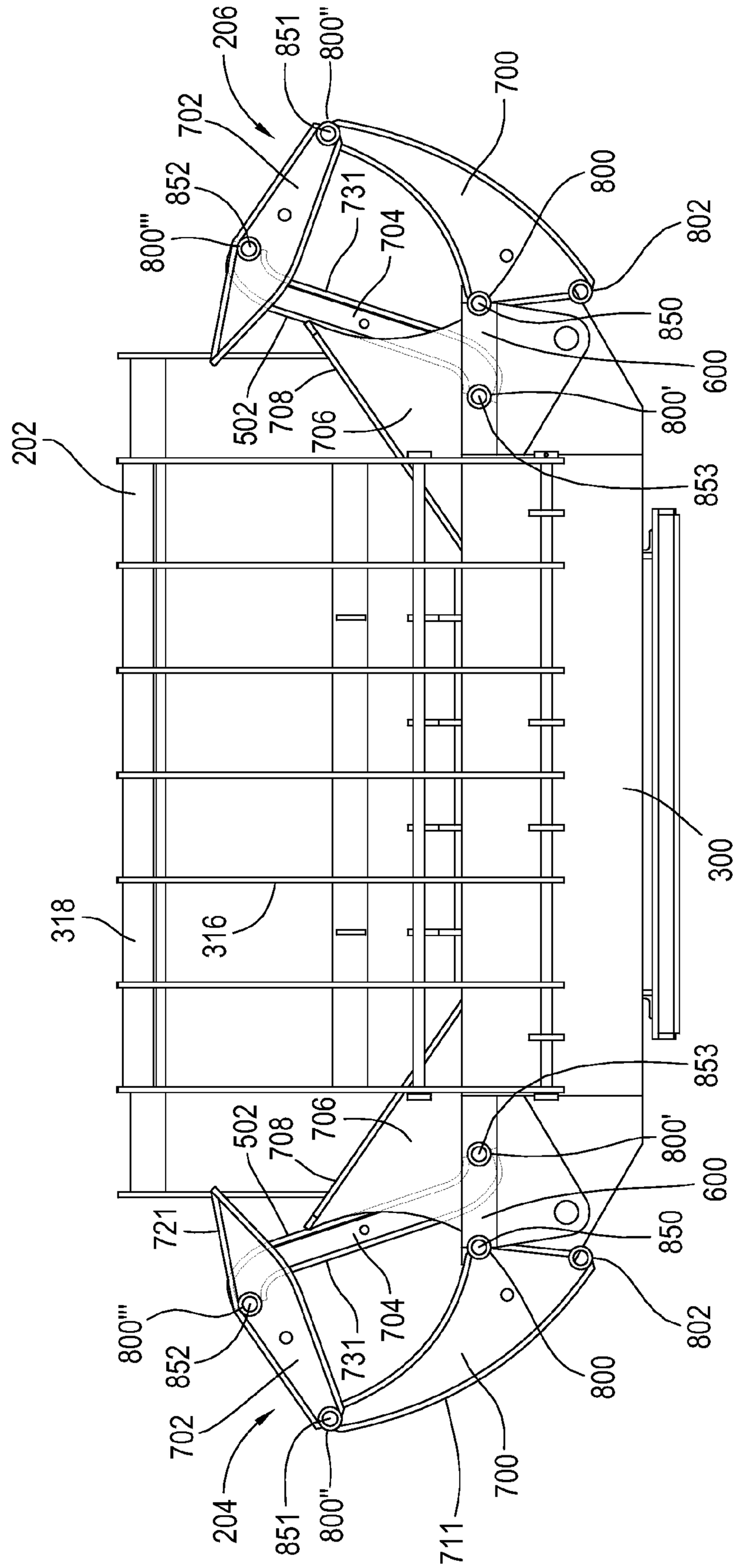
704
706
310
402
208
302
706
704
721
700
702
749
204

Fig. 6


206
851
800"
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702
852
731
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800'''
704
802
850
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800'
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708
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318
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706
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800'''
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802
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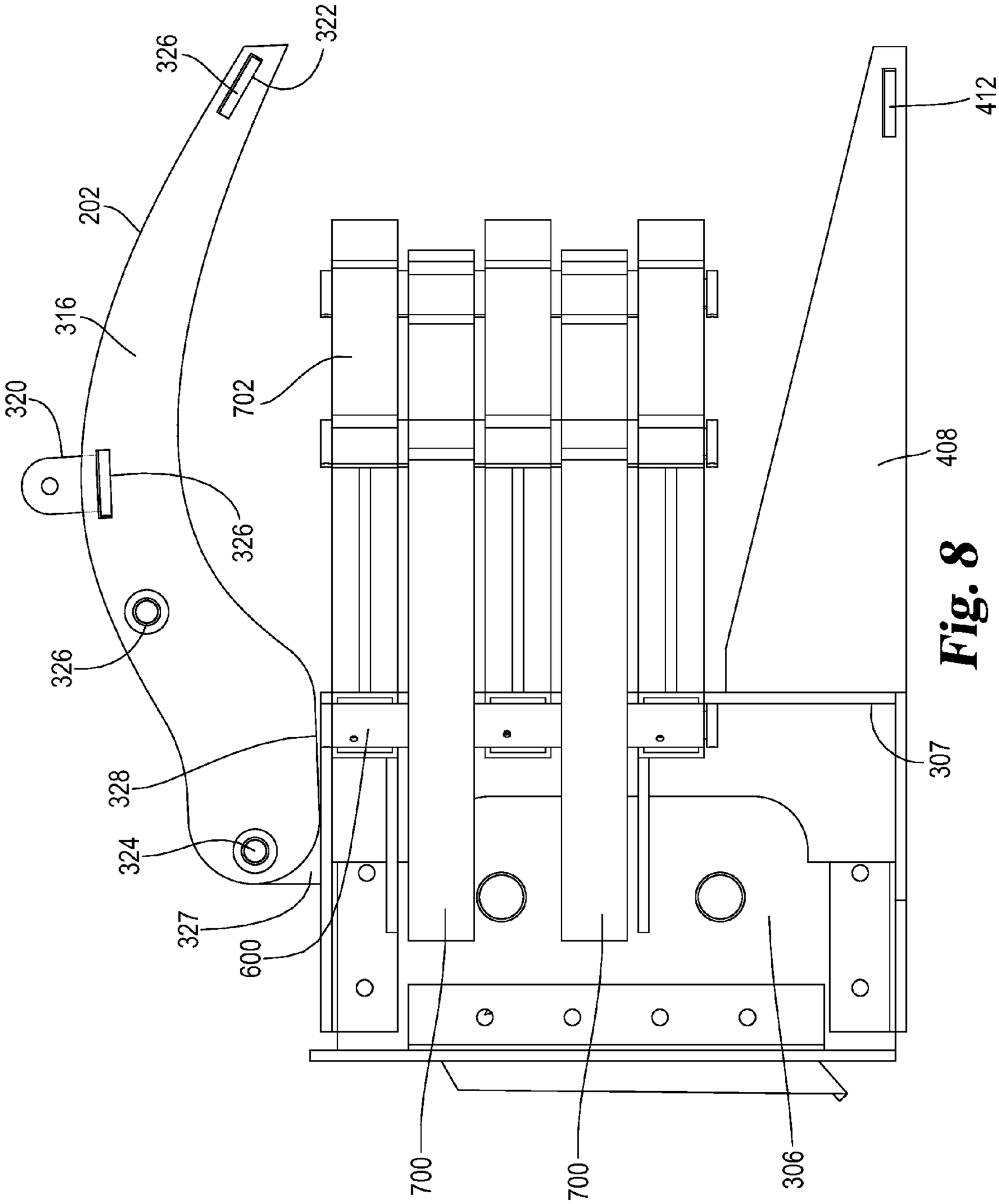
702
204
851
800"
711
700

Fig. 7


326
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202
316
320
702
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324
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600
700
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Fig. 8

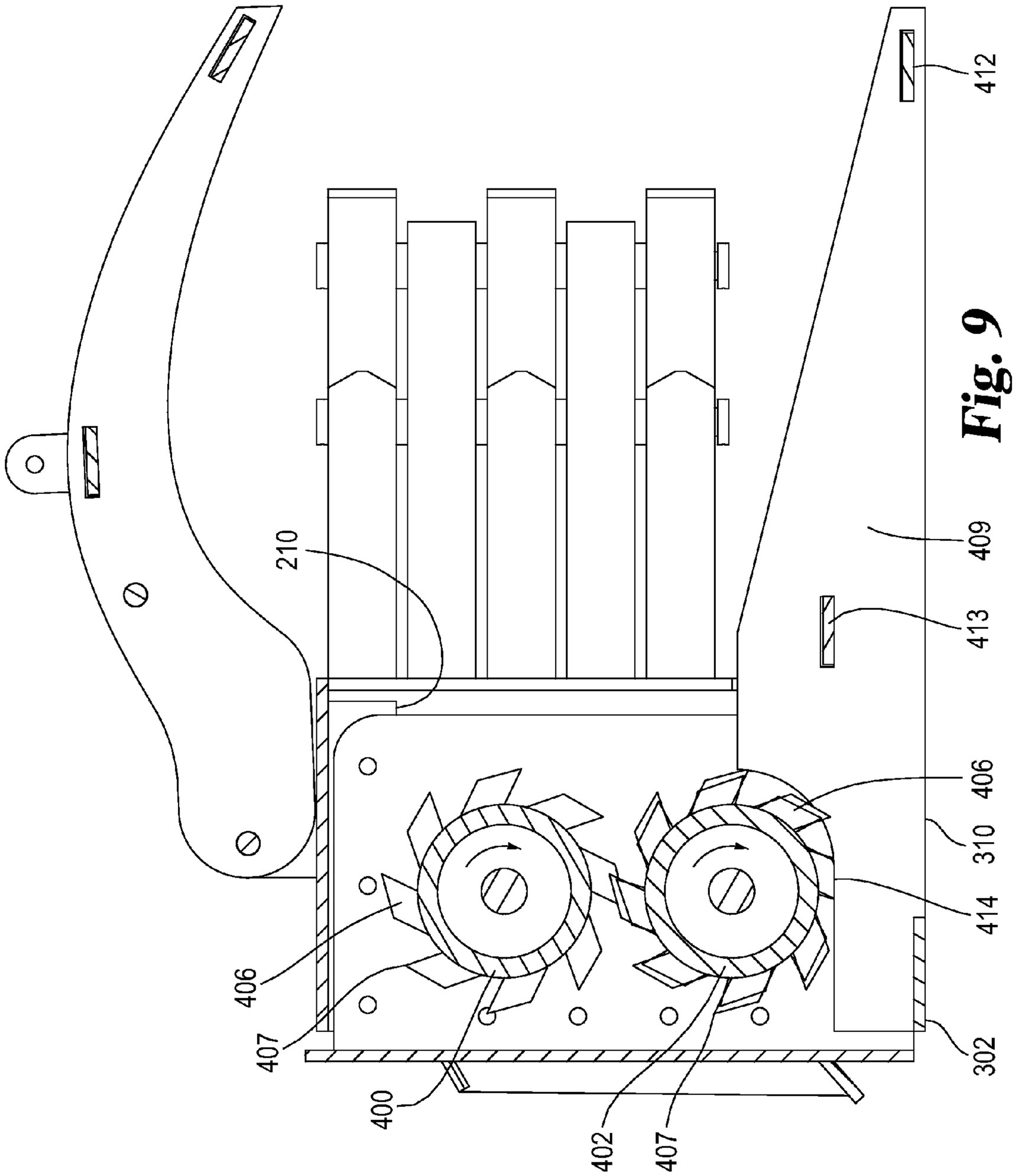

Fig. 9

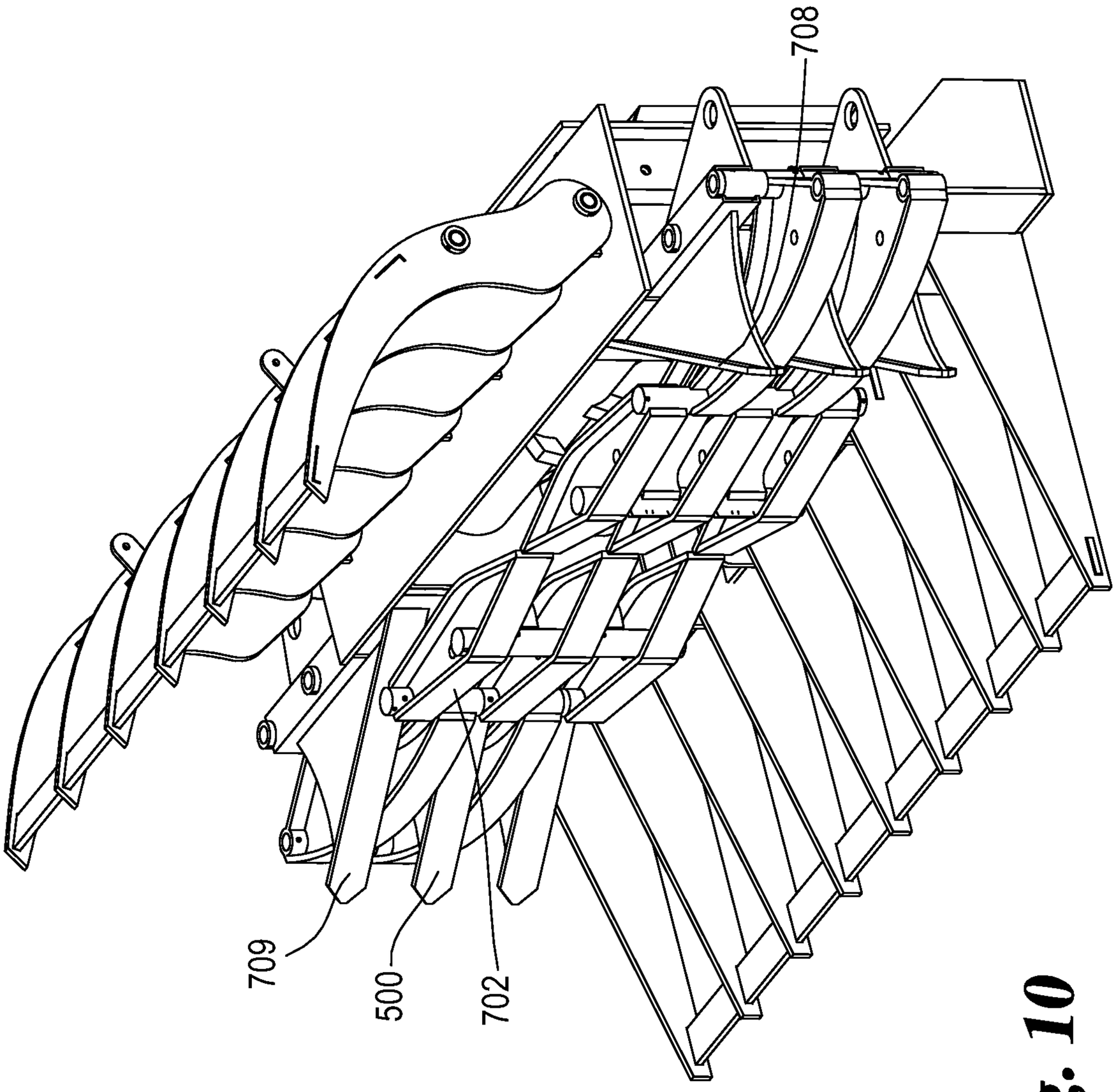

Fig. 10

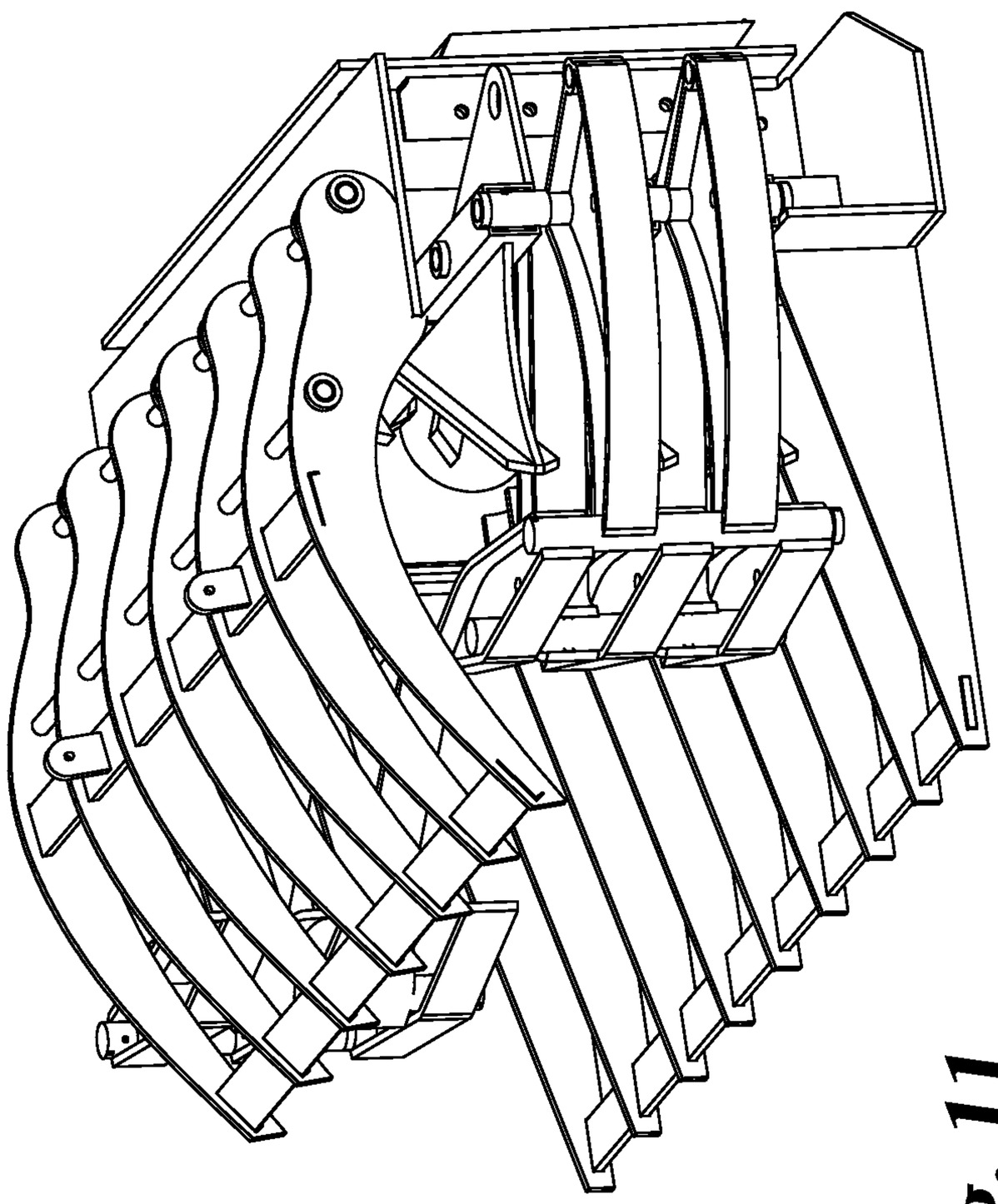

Fig. 11

GRAPPLE GRINDER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 61/638,524 filed Apr. 26, 2012, which is hereby incorporated by reference.

BACKGROUND

The present disclosure relates to a hydraulic or other power driven device for use in cleanup of debris after natural disasters, demolition or construction site cleanup as well as other applications. The device described herein is a system that is added to prime movers such as skid-steer loaders and other construction equipment, but is believed to be useful in other applications as well.

Debris fields are created from natural disasters (e.g. tornadoes, hurricanes, ice storms, and floods, etc.) as well as through man-made projects such as demolition. A major problem involves removing grindable debris before reconstruction can occur. Traditionally, natural or man-made debris is gathered by loaders of various types and placed into trucks to be taken to remote areas where the debris will be processed. In some cases, columns of dump trucks transport debris between the debris fields and a dumpsite. At the dumpsite, the debris is either burned or reduced to debris which is easier to handle. Alternatively, the debris can be placed directly into a landfill. When trucks are used to remove debris from the debris site in its natural state, the trucks are often only minimally loaded from a weight perspective due to the intrinsically low density and high volume of tangled masses of trees, other natural debris, and sometimes man-made debris. This limits the speed of the debris removal as the trucks are not loaded to their weight capacity. Accordingly, the efficiency of the removal process is greatly reduced.

In some cases, stationary chippers or grinders can be located at the debris field and used to reduce the volume of the debris by rending it into smaller chunks or chips so that trucks can haul off a more compact product. However, these are expensive and inefficient to operate. Chippers and grinders are capable of being loaded by only one vehicle at a time. Additionally, chippers and grinders are capable of loading reduced or treated debris into one truck at a time. The debris must be moved twice. The debris must first be transported through the debris field to the chipper or grinder. The debris must then be loaded onto a truck and transported from the debris field to the dumpsite. These procedural steps slow the process of removing debris from the debris field greatly by requiring set up and additional transport time.

Thus, there is a need for a system that is capable of speeding up the debris clearing process as well as providing high density shredded debris in order to increase efficiency and to save fuel, time, and other costs of the cleanup operation.

SUMMARY

A grinder unit, such as the examples described herein, addresses the issues mentioned above as well as others. This is achieved by a portable grinder unit which can readily be moved about a debris site to comminute debris on location, leaving shredded debris which is ready to be loaded onto trucks for transport. The portable grinder unit allows an increase in the efficiency and utilization of transport trucks by facilitating filling of the trucks to their maximum weight capacity without the need for stationary grinders or chippers.

In one example, a device includes a grinder unit with a frame defining a vertical facing feed opening for receiving debris to be comminuted. The feed opening has a top edge and two lateral sides. A top grapple arm can be pivotally mounted to the frame adjacent to the top edge of the feed opening. At least one side grapple arm can be movably mounted to the frame adjacent to a side of the feed opening so that the side grapple arm is pivotable between a receive position and a feed position. The side grapple arm can advance debris toward the feed opening when moving from the receive position to the feed position. The pivot axes of the top grapple arm and the side grapple arm can be non-parallel.

The device can include a pair of side grapple arms pivotally mounted to the frame adjacent to opposite sides of the feed opening so that the side grapple arms are each pivotable between a receive position and a feed position. The side grapple arms can advance debris towards the feed opening when moving from the receive position to the feed position. The pair of side grapple arms can be pivotable relative to each other. The side grapple arms can be movable within a height between the top grapple arm and the bottom member.

Each side grapple arm can include a coupler for pushing debris so that when in the feed position, the couplers are aligned with and adjacent to the feed opening. Each side grapple arm can include a four-bar mechanism having a rocker and/or crank so that when moving between the receive position and the feed position, the coupler rotates less than the rocker and/or crank relative to the grinder unit. Each four-bar mechanism can include a plurality of couplers and a plurality of rockers and/or cranks so that the rockers are interleaved with the couplers.

The grinder unit can include a bottom member extending forward from the frame. The bottom member can have an inclined surface for moving debris vertically towards the feed opening. The top grapple arm can rotate about an axis that is nonparallel to the axes of the side grapple arms. The device can include a discharge opening defined by the frame and positioned below the grinder unit for passage of comminuted debris. The grinder unit can be attached to a skid-steer loader including a hydraulic system for providing mechanical power to the side grapple arm and top grapple arm.

In one example, a device includes a grinder unit with a frame defining a vertical facing feed opening for receiving debris to be comminuted. The feed opening has a top edge, two lateral sides, and a bottom portion. A bottom member can be attached to the grinder unit to wedge beneath debris when the grinder unit is advanced toward debris. A pivotable top grapple arm can be attached adjacent to the top edge of the feed opening to compress debris and reduce the height of the debris. A pair of movable side grapple arms can be attached adjacent to the sides of the feed opening to move debris between the bottom member and the top grapple arm and towards the feed opening.

Further forms, objects, features, aspects, benefits, advantages, and examples of the present disclosure will become apparent from a detailed description and drawings provided herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front perspective view of a grinder system including a grinder unit attached to a skid-steer loader.

FIG. **2** is a perspective view of the grinder unit of FIG. **1**.

FIG. **3** is a rear perspective view of the grinder unit of FIG. **1**.

FIG. **4** is a front perspective view of the grinder unit of FIG. **1**.

FIG. **5** is a front view of the grinder unit of FIG. **1**.

FIG. **6** is a bottom view of the grinder unit of FIG. **1**.

FIG. **7** is a top view of the grinder unit of FIG. **1**.

FIG. **8** is a side view of the grinder unit of FIG. **1**.

FIG. **9** is a side cross-sectional view of the grinder unit of FIG. **1**.

FIG. **10** is a front perspective view of the grinder unit of FIG. **1** having side grapple arms positioned in the feed position and the top grapple arm positioned in the top arm receive position.

FIG. **11** is a front perspective view of the grinder unit of FIG. **1** having the top grapple arm positioned in the top arm feed position and side grapple arms positioned between the receive position and the feed position.

DESCRIPTION OF THE SELECTED EXAMPLES

For the purpose of promoting an understanding of the principles of the disclosure, reference will now be made to the examples illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is thereby intended. Any alterations and further modifications in the described examples, and any further applications of the principles of the disclosure as described herein are contemplated as would normally occur to one skilled in the art to which the disclosure relates. One example of the disclosure is shown in detail, although it will be apparent to those skilled in the relevant art that some features which are not relevant to the present disclosure may not be shown for the sake of clarity.

Referring generally to FIG. **1**, a grinder system includes a grinder unit **100** which is attached to a support vehicle, one example of which is a skid-steer loader **102**. A typical skid-steer loader **102** is a type of support vehicle having a frame, four wheels or tracks, an operator position such as a cage or cab with a seat, and a pair of left and right front lift arms **104**. The skid-steer loader **102** includes one or more hydraulic cylinders **106** which are part of a hydraulic power system. Various powered work tool implements can be interchangeably mounted to the skid-steer loader, for example by being coupled and uncoupled from the lift arms **104**. The hydraulic system can be selectively coupled directly or through an interface to certain work implements (for example, the grinder unit **100**) to provide hydraulic power to the implements. Generally the skid-steer loader and any work implements can be controlled by an operator through a control accessible by the operator.

Referring generally to FIGS. **2-11**, the grinder unit **100** includes a frame **200**, a top grapple arm **202**, side grapple arms **204**, **206** (i.e. a left grapple arm **204** and a right grapple arm **206**), a bottom member **208**, and a vertical facing feed opening **210**. Positioned within the frame **200** is a top grinder head **400** and a bottom grinder head **402** (FIG. **4**). The grinder heads **400**, **402** may receive debris, comminute or rend the debris into smaller, shredded pieces, and pass the shredded debris through the grinder unit **100**. Generally, during use, the grinder unit **100** is moved through a debris field toward debris. The grinder unit **100** may receive debris fed into the grinder head over the bottom member **208**. The top grapple arm **202** may pivot and push debris downward and the side grapple arms **204**, **206** may pivot and push debris inward from the sides as well as towards the feed opening **210**.

As illustrated, the frame **200** includes a top plate **300** (FIGS. **3** and **7**), a bottom plate **302** (FIGS. **3** and **6**), sidewalls **306** (FIGS. **3** and **8**), front plates **307** (FIG. **5**), and a back plate or debris shield **308** (FIG. **3**). The sidewalls **306** span the distance between the top plate **300** and the bottom plate **302**. Similarly, the front plates **307** and the debris shield **308** span the distance between the top plate **300** and the bottom plate **302**. The feed opening **210** has a width defined by the distance between the front plates **307** and a height defined by the distance between the top plate **300** and the bottom plate **302**. The top plate **300** defines a top edge of the feed opening **210**. On either side of the feed opening **210**, the intersection between the side walls **306** and the front plates **307** defines lateral sides of the feed opening **210**. A bottom portion of the feed opening **210** is adjacent to and partially defined by the bottom member **208** and is positioned opposite from the top edge. The top plate **300**, bottom plate **302**, sidewalls **306**, and debris shield **308** form a grinding cavity **404** (FIG. **4**). The grinder heads **400**, **402** are rotatably mounted to the frame **200** within the grinding cavity **404** and adjacent to the feed opening **210**.

The front plates **307** include a bottom portion for mounting a part of the bottom member **208** as well as a top portion for mounting a part of the side grapple arms **204**, **206** (e.g. FIG. **4**). The bottom plate **302** includes a discharge opening **310**. The discharge opening **310** is an opening or space defined by the bottom plate **302**. The debris shield **308** provides a barrier between shredded debris and the support vehicle as well as providing a guiding surface to allow shredded debris to pass through the discharge opening **310**. In some examples, the frame **200** can include mounts **311** (FIG. **3**) positioned at either side of the grinder unit **100**. The frame **200** is generally configured to be mounted to the lift arms **104** of the skid-steer loader **102** or other support vehicle via mounts **311**. In other examples, mounts can be positioned at other locations of the frame for attachment to a skid-steer loader **102** or other vehicles.

The use of side grapple arms provides a grinder unit that is not only portable, but also provides effective and efficient rending of debris. The side grapple arms **204**, **206** are attached to the frame **200** adjacent to the lateral sides of the feed opening **210** and allow the grinder unit **100** to move debris towards the feed opening **210**. Referring generally to FIGS. **2-11**, the side grapple arms **204**, **206** are each configured as four-bar linkage mechanisms having vertically stacked and spaced grapple arm linkage elements which share common pivot axes. The four-bar linkage provides the side grapple arms **204**, **206** with a motion that is advantageous for moving debris from the bottom member **208** through the feed opening **210**. The linkage elements of the side grapple arms **204**, **206** may include pluralities of fixed links **600**, cranks **700**, couplers **702**, and rockers **704** (e.g. FIGS. **2**, **3**, and **7**). The grapple arm linkage elements may be configured in a stacked arrangement having three each of the fixed links **600** and the couplers **702**, and two each of the cranks **700** and the rockers **704**. The cranks **700** and rockers **704** can be interleaved vertically between the fixed links **600** and the couplers **702**. In the illustrated example, the grinder unit **100** includes two side grapple arms **204**, **206**. For clarity, in portions of the following description, parts of a single side grapple arm are described. However, it should be understood that the description applies to both side grapple arms **204**, **206**.

A plurality of pivot joints **800** rotatably connect the linkage elements of the grapple arms **204**, **206**, and generally share a common structure. Pivot joints **800** having similar function and positioned at different axes in the grapple arms **204**, **206** are referred to herein as pivot joints **800**, **800'**, **800"**, and **800'"**. The pivot joints **800** may be any of a variety of pivotal coupling means which are known in the art. In the illustrated example, the pivot joints **800** include a bushing (i.e. hollow cylindrical portion) which is integrated with or attached to a linkage element (e.g. the fixed links **600**). The cylindrical

portion is oriented with an axis extending vertically. The cylindrical portion is configured to accept an axle, pivot pin, or other suitable structure. Bearings, lubricants, or other devices may be used to rotatably couple the shaft with the cylindrical portions. In some examples, multiple linkage elements are interleaved in which case the multiple linkage elements are all rotatable about a single axis via a pivot joint **800**.

The fixed links **600** (or ground links) are support beams which are attached at one end to the frame **200**, and are thus fixed relative to the frame **200**. The fixed links **600** provide support for the moving parts of the side grapple arms **204**, **206**. In the illustrated example, the fixed links **600** are beams in the form of hollow structural sections having a substantially rectangular profile, although, other types of beams or supports could be used. In the illustrated example, the side grapple arms **204**, **206** include three fixed links **600** (FIG. **8**). Other examples can include more or less fixed links **600**. At the end of the fixed links **600** that are opposite to the frame **200** are pivot joints **800** positioned at axis **850**. An additional pivot joint **800'** is positioned at axis **853** between the frame **200** and the pivot joint **800** (e.g. FIG. **7**). The pivot joints **800** rotatably connect the fixed links **600** to the cranks **700**, and the pivot joints **800'** rotatably connect the fixed links **600** to the rockers **704**, as described below.

A plurality of biasing plates **706** can be attached to the fixed links **600** and to the frame **200**. The biasing plates **706** are formed as three sided objects with one side attached to a side surface of the fixed links **600** and also to the front plate **307**. The biasing plates **706** may include flanges **708** attached to one side of the biasing plates **706**. The flanges **708** extend at an angle outward from the feed opening **210**. The flanges **708** have a biasing surface **500** which tends to guide debris inward towards the grinder heads **400**, **402** when the side grapple arms **204**, **206** push debris towards the feed opening.

The cranks **700** are formed as a three sided structural element having a flange **711** extending along each side (e.g. FIGS. **2** and **7**). The structure is similar to a modified I-beam configuration which provides a structurally rigid frame while minimizing the mass of the cranks **700**. The cranks **700** may be vertically offset and interleaved with the fixed links **600**. Each side grapple arm **204**, **206** includes two cranks **700**, although in other configurations more or less cranks **700** are included. The cranks **700** have pivot joints **800** which couple with the pivot joints **800** of the fixed links **600** at axis **850**. The cranks **700** also have a pivot joint **800"** positioned at one end of the cranks **700** that rotatably connects the cranks **700** to the couplers **702** at axis **851**.

The couplers **702** are formed as an elongated quadrilateral having four sides. The couplers **702** are formed in a modified I-beam configuration (similar to the cranks **700**) and may have a flange **721** extending along the sides (e.g. FIG. **7**). The couplers **702** are vertically offset from and interleaved with the cranks **700**. Each side grapple arm **204**, **206** includes three couplers **702**, although in other configurations more or less couplers **702** are be included. The couplers **702** may include a pivot joint **800"** at axis **851** and positioned at an end of the couplers **702**. The end opposite of the pivot joint **800** at axes **851** has sides which form an acute angle. A pivot joint **800'"** is positioned between the two ends of the couplers **702** at axis **852**. The pivot joint **800"** is aligned with axis **851** and couples with the pivot joint **800"** of the cranks **700**. The pivot joint **800'"** at axis **852** provides a rotatable connection to the rockers **704**.

The rockers **704** are formed generally in an elongated "S" shape. The rockers **704** are also formed in a modified I-beam configuration and have a flange **731** extending along the sides (e.g. FIG. **7**). Each side grapple arm **204**, **206** includes two rockers **704**, although in other configurations more or less rockers **704** may be included. The rockers **704** are vertically offset and interleaved with the couplers **702**. The rockers **704** include a pivot joint **800'"** positioned at one extent of the "S" shape. The pivot joint **800'"** provides a rotatable connection between the rockers **704** and the couplers **702** at axis **852**. The rockers **704** also include a pivot joint **800'** positioned at the other extent of the "S" shape. The pivot joints **800'** provide a rotatable connection between the rockers **704** and the fixed links **600** at axis **853**.

The side grapple arms **204**, **206** may be movable between a receive position (e.g. FIGS. **1** and **7**) for receiving debris to be comminuted, and a feed position (e.g. FIG. **10**) for feeding debris into the grinder unit **100**. The four-bar mechanism configuration of the side grapple arms **204**, **206** allows the couplers **702** to maintain an advantageous angle with respect to the feed opening **210**, so that substantially all of the debris is forced into the feed opening **210**. When in the feed position, the side grapple arms **204**, **206** are more proximate to the grinder heads **400**, **402** relative to the receive position. In particular, in the feed position, the couplers **702** from each grapple arm are adjacent to one another and substantially span the feed opening **210**.

The cranks **700** include driver pivot joints **802** (FIG. **7**) which are configured to receive mechanical power for operation of the side grapple arms **204**, **206**. To engage the side grapple arms **204**, **206**, a hydraulic actuator (or other mechanical power source) can act upon the cranks **700** at the driver pivot joints **802**. This causes the cranks **700** to rotate about axes **850**. Simultaneously, the couplers **702** move about axis **850** in response to the rotation of the cranks **700**. The rockers **704** rotate about axis **853** in response to the movement of the couplers **702**. The rockers **704** constrain the couplers **702** at axis **852** while the cranks **700** constrain the couplers **702** at axis **851** which allows the couplers **702** to move through a defined path between the receive position and the feed position. The flanges **708** of the couplers **702** have surfaces **749** (FIG. **6**) which can abut against debris and urge it to move towards the feed opening **210**. Similarly, the biasing surfaces **500** of the biasing plates **706** can also abut against debris and bias it towards the feed opening **210**.

The path of the couplers **702** can be designed to pass relatively close to the outermost extent of the biasing surfaces **500** so that debris is sufficiently contained within the grasp of the grinder unit **100**. When moving from the receive position to the feed position, as the couplers **702** begin to move past the biasing surfaces **500**, the flanges **731** of the rockers **704** have surfaces **502** (FIG. **7**) which also abut against the debris and urge a portion of the debris to move towards the feed opening **210**. The interleaved configuration of the biasing plates **706** and the rockers **704** reduces gaps or spaces in the side grapple arms **204**, **206** which minimizes or eliminates debris which would otherwise escape the grasp of the grinder unit **100**. In that way, the four-bar linkage configuration of the side grapple arms **204**, **206** can facilitate a path of motion of the couplers **702** that is advantageous for collecting and rending debris.

In other examples (not shown), the side grapple arms can be a single element that is pivotable about an axis. The left grapple arm **204** may be movable independent of the right grapple arm **206**. For example, the left grapple arm **204** can be positioned in the side arm feed position while the right grapple arm **206** is positioned in the side arm receive position. Similarly, at any moment each grapple arm may be independently positionable between the side arm receive position and the side arm feed position.

The grinder unit **100** includes the top grapple arm **202** which can be used to smash debris or otherwise reduce the height of debris loaded onto the bottom member **208** so that it can enter the feed opening **210**. The top grapple arm **202** is attached to the top plate **300** adjacent to the top edge of the feed opening **210**. The top grapple arm **202** may include multiple ribs **316** (i.e. vertically-oriented plates) and supports **318** (FIG. **3**). The ribs **316** are vertically oriented and shaped with a curvature (e.g. FIG. **8**) that terminates at an end **322**. The opposite end includes a rotation coupling hole **324**. The ribs **316** also include support coupling holes **326** which are configured to receive the supports **318**. The ribs **316** are spaced apart and the supports **318** extend through the coupling holes **326** in the ribs **316**. The top grapple arm **202** is pivotally attached via a top shaft **314** and connectors **327** to the top plate **300** (FIG. **3**). The top shaft **314** extends through the rotatable coupling holes **324**. Bearings, lubrication, or other methods known in the art facilitate rotatable coupling. The top grapple arm **202** is pivotable about an axis formed by the shaft **314** between a top grapple arm receive position (e.g. FIG. **1**) and a top grapple arm feed position (e.g. FIG. **4**). Rotation of the top grapple arm **202** is bounded in the top grapple arm feed position by an abutment between an edge **328** of the ribs **316** and the top plate **300**.

The top grapple arm **202** can be configured so that when in the top grapple arm feed position, the side grapple arms **204**, **206** are movable between the side arm receive position and the side arm feed position. In other words, the top grapple arm **202** does not cross the path or restrict the movement of the side grapple arms **204**, **206** at any position (e.g. FIGS. **9** and **11**). In some examples, the top grapple arm **202** can include top connectors **320** which are configured to receive mechanical power for moving the top grapple arm between the top arm receive position and the top arm feed position.

The grinder unit **100** includes the bottom member **208** which can be used to wedge beneath debris and can provide a surface for debris to be moved upwards and into the feed opening **210**. The bottom member **208** is adjacent to the bottom portion of the feed opening **210**. The bottom member **208** may include a plurality of ribs **408**, **409** (e.g. FIG. **4**) and supports **412**, **413**. The ribs **408**, **409** (i.e. vertically-oriented plates) are vertically oriented and spaced horizontally.

It is beneficial for the grinder heads **400**, **402** to be raised from the ground-level surface so that comminuted debris can be discharged by gravity from the grinder unit **100**. For example, the ribs **408**, **409** are generally tapered from a narrow configuration at the front to a wider configuration at the rear (relative to the grinder unit **100**), or in other words, the ribs **408**, **409** are formed in wedge or ramp shapes to raise debris upward from the ground surface towards the feed opening **210**. The bottom member **208** provides a ramp which can be used to raise debris upwards or can be used as a raised surface for placing debris.

The support **412** extends through openings located near the front of the ribs **408**, **409** and provides structural rigidity to the bottom member **208** by anchoring the ribs **408**, **409**. The bottom member **208** can be wider than the feed opening **210** so that a portion of the bottom member **208** extends beyond the feed opening **210** on either side of the grinder unit **100**. In the illustrated example, the ribs **408** positioned on either side of the feed opening **210** are attached to the front plates **307** (FIG. **8**), while ribs **409** extend into the feed opening **210** and are supported by support **413**. Support **413** extends through openings located in the ribs **409**. Two of the ribs **409** can extend into the feed opening **210** and are attached to the sidewalls **306**. The ribs **409** can have a rear portion with a groove **414** to accommodate the bottom grinder head **402** (FIG. **9**) and can be attached at the rear to the bottom plate **302**. In that way, the rear portions span the discharge opening **310**.

Additional partial ribs **415** can be positioned between the ribs **408** that extend into the feed opening **210**. The partial ribs **415** are supported by support **413** which extends through openings located near the front of the partial ribs **415**. The partial ribs **415** can include a groove to accommodate the bottom grinder head **402**. The partial ribs **415** can be similarly attached at the rear to the bottom plate **302** and can span the discharge opening **310**.

The grinder heads **400**, **402** rotate within the grinder unit **100** and rend the debris into smaller pieces as it passes through the feed opening **210**. The grinder heads **400**, **402** are rotatably mounted to the frame **200** adjacent to the feed opening **210** by mounting shafts **312** which pass through the sidewalls **306** (FIG. **3**). The grinder heads **400**, **402** are thus rotatable about axes that are concentric with the shafts **312**. Bearings or other known friction-reducing devices can be included to reduce frictional energy losses during rotation of the grinder heads **400**, **402**. In some examples, the bearings can be incorporated into the sidewalls **306** so that the shafts **312** are rotatable relative to the sidewalls **306**.

At least one end of each shaft **312** can be configured to receive rotational mechanical energy. In some examples, mechanical coupling devices such as belts, chains, and gears (not shown) connect a power source to the shafts **312**. In some examples, the grinder heads **400**, **402** may each be connected to separate and independent power sources. The grinder heads **400**, **402** may be capable of rotating synchronously or independently. During one mode of operation, the grinder heads **400**, **402** rotate in the same direction and at the same rotational rates. Alternatively, the grinder heads **400**, **402** can rotate in opposite directions and/or at different rotational rates, as well as any combination or configuration of the above. In some examples, independent relative rotation rates are achieved with variable speed belt drives or manually changeable pulleys.

Referring generally to FIG. **9** (showing a cross-section of the grinder unit **100** and likewise the grinder heads **400**, **402**), the grinder heads **400**, **402** include teeth **406** (or cutters) positioned on the outer surfaces of the grinder heads **400**, **402** (FIG. **9**). In some examples, the teeth **406** are separate parts that are welded to the outer surface of the grinder heads **400**, **402**. In other examples, the teeth **406** are formed as part of the grinder heads **400**, **402**. The teeth **406** can be positioned about the outer surfaces of the grinder heads **400**, **402** so that they are spaced from one another in both the axial direction as well as radially, or in the circumferential direction relative to the grinder heads. In other words, the teeth **406** can be configured in a pattern of discrete bands extending circumferentially about the surface of the grinder heads **400**, **402**. Within the bands, the teeth **406** can be positioned intermittently. The discrete bands are separated from one another in the axial direction by a distance that is at least as wide as the teeth **406** to allow passage therebetween of the teeth **406** from the counterpart grinder head. In that way, the teeth **406** of the top grinder head **400** are aligned with circumferential spaces (or gaps) between the teeth **406** of the bottom grinder head **402** (FIG. **5**), and the teeth **406** of the bottom grinder head **402** are aligned with circumferential spaces between the teeth **406** of the top grinder head **400**.

The teeth **406** can be positioned on the grinder heads **400**, **402** in an orientation that is angularly offset relative to the center axis of rotation (e.g. FIG. **9**). Each of the teeth **406** may include a cutting edge **407** positioned on the leading side of the teeth **406** relative to the direction of rotation. In one

example, the grinder heads **400**, **402** are configured to both rotate in a clockwise direction (relative to the configuration of FIG. **9**). In the illustrated example, two teeth **406** are spaced equidistant from one another within the circumferential bands and axially offset from neighboring circumferential bands. Each circumferential band can include more or fewer than two teeth **406**. The teeth **406** of the bottom grinder head **402** can be positioned to have some overlap in the vertical direction with the teeth **406** of the top grinder head **400** when the teeth **406** are proximate (e.g. FIGS. **5** and **9**). In that way, the teeth **406** of the top grinder head **400** and the bottom grinder head **402** rotate in an interleaved configuration.

The spacing between the teeth **406** between the grinder heads **400**, **402** determines the size of debris (and therefore the density) that can be produced. In various examples, the teeth **406** can have varied sizes. For example, particular circumferential bands of teeth **406** can have widths or heights that are different from other circumferential bands. In some examples, the teeth **406** can have widths or heights that are varied even within a single circumferential band. In other examples, the teeth **406** can be spaced in non-equidistant configurations and/or include different numbers of teeth **406**. In some examples, the teeth **406** can be sized and spaced randomly within the circumferential bands. In some examples, the grinder heads **400**, **402** can be sized differently (e.g. having different diameters).

The interleaved configuration (or staggered arrangement) and the angular offset positioning of the teeth **406** of the grinder heads **400**, **402** are advantageous for rending debris. The grinder heads **400**, **402** impact debris as it passes through the feed opening **210**. Because the teeth **406** move in opposing directions at the location where the teeth **406** of the two grinder heads **400**, **402** are proximate, the forces applied to the debris by the teeth **406** at this location are opposite. This results in a generally neutral laterally-directed pull force on the debris. The opposing interaction of the teeth **406** of the top grinder head **400** with the teeth **406** of the bottom grinder head **402** causes a shearing force which cuts, shreds, and/or otherwise rends the debris. The cutting edges **407** enhance the rending. The neutral pull force on the debris tends to allow the debris to stay in the proximity of the grinder heads **400**, **402** where it is continually rended into smaller and smaller pieces. The grinder heads **400**, **402** and the teeth **406** can be configured to provide spaces therebetween for smaller pieces of rended debris to pass through and ultimately through the discharge opening **310**. The downward pull force from the forward portion of the bottom grinder head **402** tends to move smaller pieces of rended debris toward the discharge opening **310**. Similarly, the rotational motion of the top grinder head **400** tends to move smaller pieces of rended debris toward the debris shield **308**. The debris shield **308** deflects the rended debris and subsequently the rended debris falls downward through the discharge opening **310**.

The configuration of grinder heads **400**, **402** avoids problems with single head grinders as well as dual head grinders that rotate in opposing directions. Single head grinders and dual head grinders rotating in opposite directions tend to pull debris into the cutting area which can choke the cutting area and slow the rending process while simultaneously providing little control over the feed rate into the grinder heads. By rotating the grinder heads **400**, **402** in the same direction, a neutral pull effect on the debris is achieved and the feed rate can be controlled by the side grapple arms **202**, **204** as they are advanced toward the grinder heads **400**, **402**. In various examples, the relative speed of each grinder head can be varied to compensate for differences in the debris being processed.

The grinder unit **100** can be configured to apply controlled mechanical power at multiple locations. The mounting shafts **312** of the grinder heads **400**, **402** can each be configured to receive independent rotational mechanical power to make the grinder heads **400**, **402** rotate about the axes of the mounting shafts **312**. The side grapple arms **204**, **206** can each be configured to receive independent translational and rotational mechanical power at the driver pivot joints **802** in order to rotate the side grapple arms **204**, **206** between the receive position and the feed position. The top grapple arm **202** can be configured to receive mechanical power at the top connectors **320** in order to pivot the top grapple arm **202** between the top arm receive position and the top arm feed position.

Mechanical power can be supplied by a variety of sources which are known in the art. In one example mechanical power can be supplied hydraulically or by a diesel engine. In other examples, the grinder unit **100** can be be attached to a vehicle which is capable of carrying the extra weight of a dedicated power source (such as a diesel powered engine). In other examples, the grinder unit **100** can be attached to a vehicle (such as the skid-steer loader **102**) which is capable of powering the grinder unit **100** with its own power source, such as a hydraulic power system. In still other examples the grinder unit **100** can be configured as an independent unit having its own power source that is capable of being transported to a debris site and operated independent of any vehicle. When mounted to the skid-steer loader **102**, the grinder unit **100** utilizes the hydraulic power of the skid-steer loader **102**. In that case, hydraulic actuators (not shown) are powered by the hydraulic system of the skid-steer loader **102** in order to drive the side grapple arms **204**, **206**, the top grapple arm **202**, and the grinder heads **400**, **402**.

An operational example of the grinder unit **100** will now be described in the context of the grinder unit **100** mounted to the skid-steer loader **102**. The grinder unit **100** is moved about a debris site by the skid-steer loader **102**. If mounted to the lift arms **104**, the grinder unit **100** may be raised above ground level in order to be transported to an area where it is desirable for debris to be rended and shredded into smaller pieces. The grinder unit **100** is raised or lowered to a target level (i.e. a desired level) and the grinder heads **400**, **402** are powered to rotate. In the initial stage, to begin receiving debris, the side grapple arms **204**, **206** are positioned in the receive position and the top grapple arm **202** is positioned in the top arm receive position (FIG. **1**).

The skid-steer loader **102** can then load debris onto the grinder unit **100** by wedging the bottom member **208** beneath the debris and moving forward to move debris onto the bottom member **208**. The bottom member has an inclined surface which guides debris upwards and towards or into the feed opening **210**. Alternatively, debris is pushed or moved on to the bottom member **208**. In some instances the debris to be comminuted may have a height which is too large to fit within the grinding cavity **404** via the feed opening **210**. In that case, the top grapple arm **202** can be engaged. The top grapple arm **202** is powered to rotate and move from the top arm receive position towards the top arm feed position. When moving from the top arm receive position to the top arm feed position, the top grapple arm **202** can engage debris and smash or otherwise bias it downwards towards the bottom member **208**, thereby reducing the height of the debris. The top grapple arm **202** can be moved as desired up to its fully closed feed position (e.g. FIG. **2**).

After the top grapple arm **202** is positioned as desired, the side grapple arms **204**, **206** can be engaged and moved from the receive position towards the feed position in order to move debris further towards the grinder heads **400**, **402**, as shown in

FIG. **11**. When the side grapple arms **204**, **206** are fully in the feed position, the couplers **702** substantially span the feed opening so that substantially all of the debris is moved into the feed opening **210**.

Generally, the grinder heads **400**, **402** can interact with the debris and rend the debris into smaller pieces. As debris is being rended (or processed) by the grinder heads **400**, **402**, the debris includes pieces of various sizes. The grinder heads **400**, **402** are designed to continue the rending process on larger pieces of debris while rended pieces of debris that are sufficiently small pass through the grinder unit **100** and are expelled through the discharge opening **310**. In that way, at any moment during the grinding process, the grinder unit can generally include debris at various states of comminution, and the term "debris" as used herein refers to the same.

The grinding process can continue until the debris is substantially shredded and expelled through the discharge opening **310**. At that time, if the top grapple arm **202** is in a closed or partially closed position, it can be moved to the top arm receiving position. Similarly, the side grapple arms **204**, **206** can be moved out of the feed position to the receive position (FIG. **1**) and the grinding process can continue by introducing more debris to the grinder unit **100** which can include loading debris onto the bottom member **208** or moving the grinder unit **100**. In some circumstances, the grinder unit **100** can be moved to a new location while debris is being shredded. The expelled comminuted debris remains behind, where it is ready to be loaded into a truck for removal or other suitable processing.

The grinder unit **100** can be constructed in a partial skeleton fashion including the ribs **408**, **409** of the bottom member **208** as well as the ribs **316** of the top grapple arm **202**. This reduces the weight of the grinder unit **100** while maintaining sufficient structural rigidity to perform necessary functions. Similarly, parts of the side grapple arms **204**, **206** can be constructed as modified I-beams which further reduce the weight while maintaining strength and structural rigidity. The reduced weight allows the grinder unit **100** to be mounted to a wide variety of support vehicles, facilitating ease of transport about a debris field. As an added function, the spaced configuration of the ribs **408**, **409** of the bottom member **208** allows smaller pieces of debris and/or shredded debris to fall downward and pass between the ribs **408**, **409**, thereby ensuring that larger pieces of debris pass through the feed opening **210**.

Although specific mention of materials was not included for all parts of the grinder unit **100**, various suitable materials can be used. In one example, the grinder unit **100** and all parts thereof can be constructed of a suitable material such as steel. In other examples, the grinder unit **100** can be constructed of other materials which are sufficiently rigid and strong. In some examples, various parts of the grinder unit **100** can each be constructed of different suitable materials.

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred example has been shown and described and that all changes, equivalents, and modifications that come within the spirit of the disclosures defined by following claims are desired to be protected.

The invention claimed is:

1. A device, comprising:

a grinder unit having a frame defining a vertical facing feed opening for receiving debris to be comminuted, said opening having a top edge and two lateral sides;

a top grapple arm pivotally mounted to the frame adjacent to the top edge of the feed opening;

at least one side grapple arm moveably mounted to the frame adjacent to a side of the feed opening, wherein the side grapple arm is pivotable between a receive position and a feed position and wherein the side grapple arm can advance debris toward the feed opening when moving from the receive position to the feed position; and

wherein the pivot axes of the top grapple arm and the side grapple arm are non-parallel.

2. The device of claim **1**, further comprising a pair of side grapple arms pivotally mounted to the frame adjacent to opposite sides of the feed opening, wherein the side grapple arms are each pivotable between a receive position and a feed position and wherein the side grapple arms can advance debris towards the feed opening when moving from the receive position to the feed position.

3. The device of claim **2**, wherein the pair of side grapple arms are pivotable relative to each other.

4. The device of claim **2**, wherein each side grapple arm has a coupler for pushing debris and wherein when in the feed position, the couplers are aligned with and adjacent to the feed opening.

5. The device of claim **4**, wherein each side grapple arm includes a four-bar mechanism having a rocker, and wherein when moving between the receive position and the feed position, the coupler rotates less than the rocker relative to the grinder unit.

6. The device of claim **5**, wherein each four-bar mechanism includes a plurality of couplers and a plurality of rockers, and wherein the rockers are interleaved with the couplers.

7. The device of claim **1**, further comprising a bottom member mounted to the frame opposite from the top grapple arm and adjacent to the feed opening, wherein the bottom member defines a path for debris to be advanced toward the feed opening, and wherein the path raises the debris.

8. The device of claim **1**, further comprising a discharge opening defined by the frame and positioned below the grinder unit for passage of comminuted debris.

9. The device of claim **1**, further comprising a pair of rotatable grinder heads positioned adjacent to the feed opening to receive and comminute debris through the feed opening, wherein the grinder heads are rotatable about parallel axes, and wherein the grinder heads include a plurality of cutters positioned on the outer surfaces of the grinder heads.

10. The device of claim **8**, wherein the grinder heads are configured to rotate about parallel axes in the same rotational direction.

11. The device of claim **1**, wherein the grinder unit is attached to a skid-steer loader including a hydraulic system for providing mechanical power to the side grapple arm and top grapple arm.

12. A device comprising:

a grinder unit having a frame defining a feed opening for receiving debris to be comminuted;

a top grapple arm pivotally mounted to the frame adjacent to the feed opening;

a bottom member mounted to the frame opposite from the top grapple arm and adjacent to the feed opening;

a pair of side grapple arms moveably mounted to the frame adjacent to opposite sides of the feed opening, wherein the side grapple arms are each moveable between a receive position and a feed position, and wherein movement of the side grapple arms from the receive position to the feed position advances debris toward the feed opening; and

a hydraulic system attached to the side grapple arms, wherein the hydraulic system provides mechanical

power for moving the side grapple arms between the receive position and the feed position.

13. The device of claim **12**, wherein the pair of side grapple arms are movable within a height between the top grapple arm and the bottom member.

14. The device of claim **12**, wherein each side grapple arm includes a four-bar mechanism having a coupler for pushing debris and a crank, wherein when in the feed position, the couplers are substantially aligned with and adjacent to the feed opening, and wherein when moving between the receive position and the feed position, the coupler rotates less than the crank relative to the grinder unit.

15. The device of claim **12**, wherein the bottom member extends forward from the frame, and wherein the bottom member has an inclined surface for moving debris vertically towards the feed opening.

16. The device of claim **12**, further comprising a pair of rotatable grinder heads positioned adjacent to the feed opening to receive and comminute debris through the feed opening.

17. The device of claim **12**, wherein the grinder heads include a plurality of cutters positioned on the outer surfaces of the grinder heads, and wherein the cutters are interleaved between the grinder heads.

18. The device of claim **12**, wherein the hydraulic system is part of a skid-steer loader.

19. The device of claim **12**, wherein the top grapple arm rotates about an axis that is nonparallel to the axes of the side grapple arms.

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